Investigation of the toxicity of sub-10 nm particles on bacterial cells from airborne samples at low mass concentration

PI Markus Petters, Co-PIs Nicholas Meskhidze & Ryan Paerl

Health impacts are usually quantified in terms of exposure to mass concentrations of particulate matter with diameter ≤ 2.5 μm ($PM_{2.5}$). Sub-10 nm particles contribute negligible mass to atmospheric $PM_{2.5}$. Yet they may contribute strongly to the overall toxic dose delivered through the aerosol. The toxicity of sub-10 nm particles is higher when compared to particles of larger size with the same composition. Sub-10 nm particles are readily taken up by cells, can cross the skin barrier, air-blood barrier, and blood-brain barrier and in turn reach sensitive organs. However, the paucity of information about their abundance, morphology, and toxicity has hampered efforts to attribute their potential health effects with disease.

We have recently identified substantial direct emissions of sub-10 nm particles in an urban environment and found that there are multiple temporally stable and spatially confined point sources within the city. It is unclear how the toxicity of environmental sub-10 nm particles differ from engineered nanoparticles, and how the toxicity might change upon release into the atmosphere. Current in in-vitro and in vivo exposure studies deliver milligrams of material. In contrast, ambient concentrations of sub-10 nm particles are on the order of ng m^{-3} of air, making collection of mg amounts unrealistic. In turn toxicology assessments through traditional methods are not possible.

This proposal addresses this challenge. The specific aim is to obtain preliminary data from new methods that can be used to evaluate the influence of sub-10 nm particles obtained from airborne samples at atmospheric concentrations on living cells.